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## **CENTRAL ARTERY TUNNEL WATER RELATED ISSUES**

This document is intended to provide a summary of issues related to water infiltration in the Central Artery Tunnel (CAT) system. There are three major sources of water inflow into the CAT system: 1) water that is carried by vehicles and the airstream they create; 2) storm water that bypasses drainage collection systems at tunnel portal entrances from roadways outside of the tunnels and; 3) infiltration of groundwater via cracks, conduit penetrations, and joints.

Infiltration of water has occurred since the first CAT tunnels were constructed and opened in 1995. Although water infiltration issues were actively being addressed, a large breach in the slurry wall of the O'Neill Tunnel in 2004 caused a partial closure of the tunnel during the evening rush hour and elevated awareness of the issues. Due to the recognition of the damaging effects of the continual moisture on electrical and structural tunnel components, procedures have been developed to survey and study various aspects of the tunnel system.

The tunnels were designed to collect and discharge all water entering the tunnels, including infiltrated groundwater, wash water, firefighting water and storm water. Collected water is discharged to the BWSC sanitary sewer system, which flows to the MWRA conveyance system and ultimately to the sewage treatment facility on Deer Island. There are 12 low Point Pump Stations in the system, which collectively discharge at 9 locations to the MWRA system.

A separate stormwater collection system captures roadway runoff at the tunnel entrance through portal trench drains and discharges to either the Charles River or Boston Harbor. In an effort to reduce flows of water bypassing portal drains, a project was designed and recently advertised to upgrade all 51 portal trench drains to more effectively intercept stormwater, thus reducing stormwater contributed water flows in the tunnel system.

MassDOT is working with the Massachusetts Water Resource Authority (MWRA), Boston Water and Sewer Commission (BWSC), Massachusetts Department of Environmental Protection (DEP), and U.S. Environmental Protection Agency (EPA), to renew permits and ensure compliance with those permits. The tunnel water is subject to the regulations of the BWSC and MWRA. There are three separate discharge permits for the tunnels, one each for the Ted William Tunnel (TWT), I-90 Connector, and O'Neill Tunnel. During initial regulatory review and permitting, extent of infiltration and volumes of water discharged by the tunnels were not anticipated by the CAT design team or regulators.

Modified permits have since been issued, which include stringent monthly reporting to MWRA, DEP and EPA of water discharge volumes and efforts to minimize infiltration. Infiltration reduction efforts have been implemented at an average cost of \$12 million per year. Currently the combined total volume of storm water and infiltration discharge is

approximately 17 million gallons per year. Additional permit requirements include bypassing the discharge of water to the BWSC/MWRA system to the surface waters. However, the MassDEP and EPA are reviewing this option due to concerns of meeting discharge standards for certain elements (eg zinc and lead concentrations in the water).

Information regarding discharge volumes has been useful for management and determination of effectiveness of leak sealing efforts and to identify trends for understanding tunnel infiltration and inflow behavior. Based on data collected since 2007, there is a cyclical correlation of flows to both seasonal temperature variations and rainfall. A lower temperature results in higher infiltration flows, due to temperature induced tunnel contractions.

Discharge data shows the continual water infiltration sealing efforts along I-93 since 2007 have been effective at reducing infiltration. In contrast, data confirms field observations that I-90 repairs to construction joints have not been effective for reducing water infiltration flows and more extensive repairs, which are in the planning stages, are required. These repairs involve deep excavations exterior to the tunnel for assessment and development of design alternatives.

During winter months, infiltrated water may cause roadway icing, which is managed through the application of deicing agents. The deicing agents themselves have impacts, accelerating corrosion in the lighting fixtures and resulting in increased airborne particulate matter in exceedance of regulatory levels. In addition, infiltrated water impacts the ability of the ventilation system to operate by restricting airflow in supply ducts and exhaust manifolds, often freezes during the winter in the ducts before the pump systems are able to work effectively, and results in the build-up of mold.

Furthermore, infiltrated water greatly contributes to a moist tunnel environment where corrosion of electrical components and conduit, structural steel, soldier piles, and the girders supporting the tunnel roof occurs. Finally, infiltrated water has saturated and damaged the tunnels' fireproofing, which is now in need of replacement. All tunnels are inspected and tested in accordance with Policy Directive developed in 2007. The inspection data, along with observations reported by maintenance and construction personnel in performing tunnel work, are used to direct work crews for water infiltration sealing efforts. The entire effort currently costs approximately \$3.2 M per year.

The water infiltration sealing efforts are prioritized first to reduce roadway wetness; minimize corrosive structural and electrical concerns; and to reduce volumes and continuous infiltration.